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HIGH-GRADE TIMOTHY and CLOVER HAY

Methods of Producing, Baling, and Loading for Market

SOIL CONSERVATION and economic feeding of livestock have caused an increased interest in the production, utilization, and marketing of timothy and clover hay.

Timothy and clover alone and in mixtures continue to form the most important hay crop in the northeastern part of the United States because they are well adapted to the soil, climate, and farm-management practices of that region.

High-quality hay cannot be produced unless the hay is cut at the proper stage of maturity. Timothy should be cut from the early- to the full-bloom stage. Clover should be cut at the half- to the full-bloom stage. Mixtures of timothy and grasses should be cut not later than when the grasses are in full bloom. When timothy and clover are cut at the proper stage of maturity they can be cured with a higher percentage of green color and feed value.

A certain amount of sweating which is caused by fermentation always occurs in the proper curing of timothy and clover hay and may improve the palatability of the hay. Excessive fermentation destroys the green color and may cause the hay to become musty or moldy.

Farmers have never given the attention to the production of hay that is given to other farm crops. High-quality hay cannot be produced unless the meadows are kept clean of weeds and other trash, the hay plants are cut at the proper stage of maturity, and the crop is cured and stored as quickly as possible.

In the preparation of hay for market proper consideration should be given to pressing the hay into neat, uniform bales and loading it on trucks or cars so as to present an attractive appearance to the buyer.

Information about the production and marketing of hay is given in Farmers' Bulletins 990, Timothy; 1339, Red Clover Culture; and 1700, Marketing Hay by Modern Methods.

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HIGH-GRADE TIMOTHY AND CLOVER HAY

METHODS OF PRODUCING, BALING, AND LOADING FOR MARKET

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IMPORTANCE OF THE TIMOTHY AND CLOVER HAY CROP

TIMOTHY AND CLOVER HAY constitute one of the major groups of hay in the United States. The soil-conservation programs will probably increase its importance in crop rotations. Timothy and clover hay made up about one-half of the total hay acreage of the United States in 1919 and approximately one-third in 1935. Even with this reduction in acreage, these kinds of hay in 1935 still occupied 20,378,000 acres—a larger acreage than alfalfa or prairie hay (figs. 1 and 2). Most of the timothy and clover hay is grown in the northeastern part of the country.

Timothy and clover continue to be the most important hay crop in the North Atlantic States, including Delaware, Maryland, Virginia, and West Virginia, but the acreage has been decreasing in the Mississippi Valley. The gradual shift from timothy, clover, and mixtures of timothy and clover in the Mississippi Valley may be due to several factors. The more important are (1) the reduction in number of horses and mules in cities and on farms, (2) the difficulty of obtaining and maintaining stands of clover in many sections, and (3) the shift to growing other legume hays such as alfalfa and lespedeza.

Timothy and clover are also grown rather extensively in certain States of the Northwest—in the irrigated sections and high mountain valleys of the Intermountain States and in the humid districts west of the Cascade Mountains. The timothy and clover acreage of Colorado, Wyoming, Montana, Idaho, Washington, and Oregon declined slightly between 1919 and 1935 but the relation of the timothy and

clover acreage to total hay acreage in these States did not change materially (fig. 2).

Various mixtures of timothy and clover hay are grown in the different areas, depending on whether the meadows are nearly pure timothy, or pure clover, or a mixture of the two. In the New England States the land is left as meadow for 3 or more years. Therefore hay grown there is chiefly mixtures of timothy and other grasses with small quantities of clover. In certain parts of New York, Pennsylvania, and Maryland the land remains as meadowland for 1 or 2 years only. There the hay is made up largely of clover the first year and of timothy thereafter. In the Mississippi Valley, particularly in the timothy-growing sections, meadows are usually left for more than 2 years, whereas clover is seldom left for more than the one crop year after the seeding year. When the clover is winter

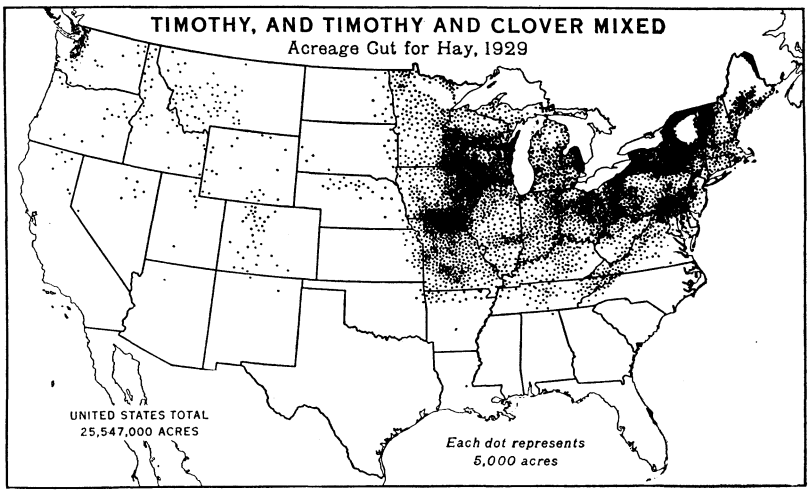

FIGURE 1.—The production of timothy and clover hay is confined chiefly to the northeastern quarter of the United States.

killed, which happens occasionally on certain types of soil, the hay consists largely of timothy the first year.

Statistics are not collected on the acreage of timothy, clover, and timothy and clover mixtures as separate crops. At present these three kinds of hay have been included under clover and timothy hay. It is not known definitely in which States the principal part of the clover and timothy hay acreage is timothy or in which States it is clover.

Yields of timothy and clover hay per acre vary widely in different localities. Clover or mixtures of timothy and clover usually outyield timothy under similar climatic and soil conditions. The average yield of timothy and clover hay in the United States in 1929 was 1.27 tons per acre. However, yields of 2½ to 3 tons of timothy per acre are often produced around Puget Sound because of the favorable growing conditions.

In those sections in which the clovers and alfalfa do not thrive very well because of soil conditions or other factors, as in much of the North Atlantic States (including Delaware, Maryland, Virginia, and

West Virginia), timothy will probably continue to be one of the most important hay plants grown. In many of these sections clovers

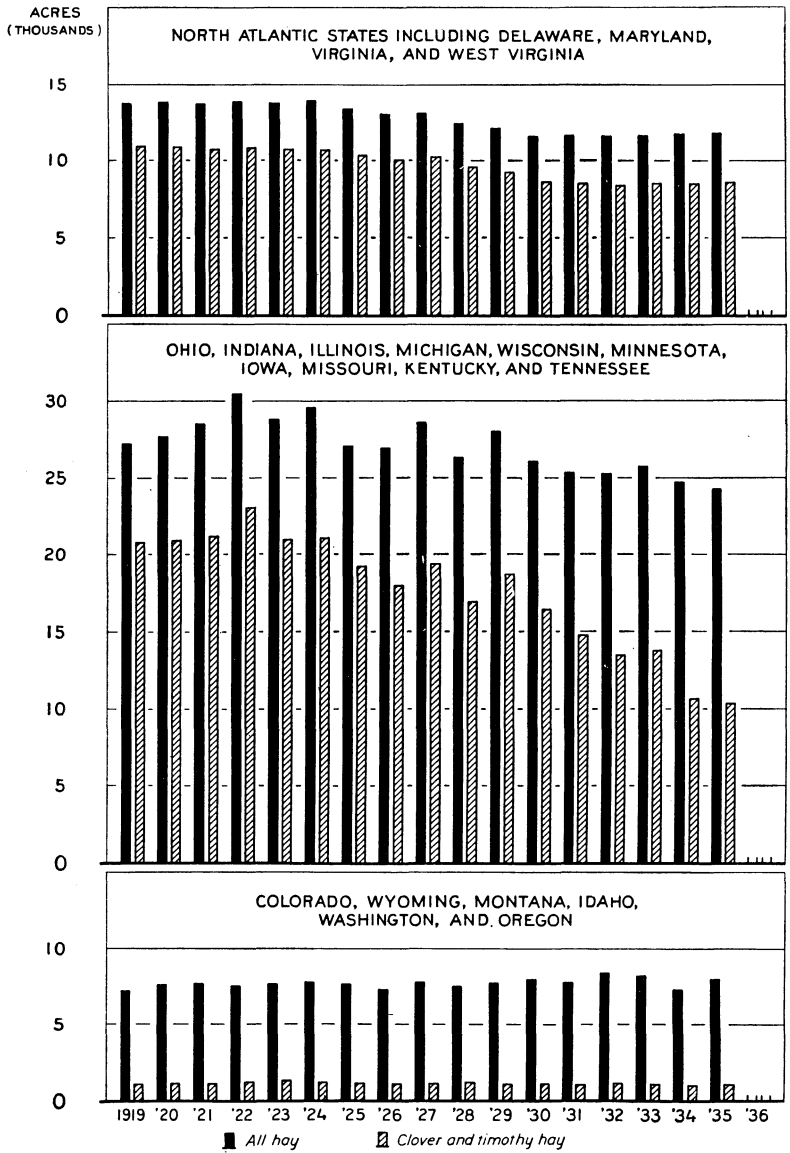

FIGURE 2.—Acreage of all hay, and clover and timothy hay in certain groups of States, 1919–35.

and alfalfa will grow but will not produce and maintain a dense stand. Under these conditions mixtures of one or more of these legumes and timothy will produce a hay mixture that has a higher feed value than timothy alone and will give greater yields per acre.

Timothy will probably continue to be the principal tame-grass hay in the northern half of the United States because of several factors: (1) Timothy thrives in a wider variety of soils and climates than any one other grass-hay plant and it yields well; (2) it has high merit as a feed for horses and mules; (3) it produces seed regularly and prolifically, the seed is easily saved and cleaned to a high purity and is difficult to adulterate, and the cost of seed per acre for sowing a crop is usually relatively low; (4) a stand is easily obtained and it makes a smooth, even sod that prevents weed growth and soil erosion; (5) its harvest season may be extended over a longer period than for other grass hays because it remains palatable during a longer period; and (6) it has value for pasture as well as for hay.

QUALITY IN TIMOTHY AND CLOVER HAY

High-grade timothy and clover hay may be defined as hay cut at the proper time, properly cured, with a large amount of natural green color, and in the case of clover with a relatively high percentage of clinging leaves. The hay must be relatively free from foreign material, undesirable mixtures, mold and must, or other objectionable odors.

Weather conditions often prevent the making of high-grade hay but production practices are usually reflected in the quality of a lot of hay. The quality of many crops of timothy and clover hay is virtually sacrificed as a result of late cutting and improper methods of curing, handling, and storing.

The quality factors employed in the United States grades for timothy and clover hay are color, foreign material, and condition. Green color is the most important of these grading factors. For many years before the standardization work on hay was undertaken by the Department of Agriculture, hay was bought and sold largely on the basis of green color. Little was known of the relationship between green color and the nutritive value of hay, yet observations of livestock feeders had definitely established a preference for green hay and experienced buyers were usually willing to pay a higher price for it. The presence of green color in hay was the buyer's insurance against unsoundness and his evidence of the approximate feeding value of the hay.

During recent years feeding tests have established a more definite relationship between green color in hay and feeding value. More consideration is now given to green color in hay production, marketing, and feeding practices, and hay producers are more and more using those haymaking and storage practices that will conserve the maximum amount of green color in the hay.

Experiments conducted by the United States Bureau of Dairy Industry show that there is a correlation between the green color and the carotene content of hay. When U. S. No. 1 Timothy, which is a grade of timothy with a relatively high percentage of green color, was fed to dairy cows as the only source of carotene or provitamin A, the cows remained in good health and reproduced normally. When the hay in the ration consisted of U. S. No. 3 Timothy that had lost most of its green color because it was overripe or weathered, the cows usually dropped immature, weak, or dead calves if fed this quality of hay for more than 6 months. When milk from cows that received the U. S.

No. 3 Timothy was fed to calves that were normal at birth, they did not make normal growth and died within 3 months. It was also shown that butter color varies definitely with the green color and carotene content of the roughage fed. Butter from cows fed U. S. No. 1 Timothy as the sole roughage had a color value that was approximately twice that of butter from cows that were fed U. S. No. 3 Timothy as the sole roughage.

EFFECT OF TIME OF CUTTING ON QUALITY OF TIMOTHY

Timothy should be cut for hay after it is fully headed out but before it has reached the full-bloom stage (fig. 3). Experiments conducted at North Ridgeville, Ohio, under a cooperative agreement

FIGURE 3.—A good stand of timothy and clover mixed hay which is being cut when the timothy is in the early- to full-bloom stage.

between this Department and the Ohio Agricultural Experiment Station showed that timothy cut when fully headed produced 1,781 pounds of dry hay per acre, which contained 128 pounds of protein. Timothy cut in the early-bloom stage produced 2,113 pounds of dry hay per acre, which contained 136 pounds of protein. Timothy cut after it had just passed the full-bloom stage produced 2,228 pounds of dry hay per acre, of which 119 pounds were protein.

The percentage of protein in the different cuttings was as follows: Timothy cut when fully headed, 7.2 percent; cut in early bloom, 6.5 percent; and cut just past full bloom, 5.3 percent. Examinations of the meadows from which the hay was cut in 1933 and 1934 disclosed no weakening or thinning effects for any stage of harvest. The early-cut plots had stands as thick and as vigorous as those cut at the later stages.

Work done at the Missouri Agricultural Experiment Station on the best time for cutting timothy gave average results per acre as follows: Timothy cut when coming into bloom had an average of 1,996 pounds of total digestible dry matter, of which 135 pounds were protein; cut in full bloom, 2,175 pounds of total digestible dry matter, of which 147 pounds were protein; cut with seed in dough, 1,914 pounds of digestible dry matter, of which 98 pounds were protein; and cut with seed ripe, 1,775 pounds of digestible dry matter, of which 92 pounds were protein.

Timothy cut from the fully-headed-out to the bloom stage has more feed value per acre than timothy cut when it has passed the bloom stage. It also can be cured with a higher percentage of green color which increases its market value as well as its feed value. As the timothy plant becomes more mature much of the protein and carbohydrates in the leaves and stems are transferred to the roots and seeds, thus increasing the percentage of crude fiber in the stems and leaves and lowering the feed value of the hay. When the leaves have ceased to function they fade and turn brown. The quality or grade of the hay is therefore reflected to a considerable extent by the presence or absence of green color.

RELATION OF MATURITY OF TIMOTHY AT TIME OF CUTTING TO COLOR

Early-cut hay will retain a larger quantity of green color than late-cut hay cured under similar conditions. From the time timothy reaches the fully-headed-out stage until it reaches the full-bloom stage there is no noticeable loss of green color due to maturity. When the plants are left standing beyond the full-bloom stage the green color fades rapidly. The leaves, beginning at the bottom, gradually turn brown and the heads and stems become greenish-yellow, then straw colored, and finally they become distinctly brown. These brown leaves have only about one-fourth the protein content of the green leaves. Early-cut timothy may lose some green color during the curing process and still retain sufficient color for the No. 1 grade. Late-cut timothy, however, which has lost some green color before being cut cannot lose any more during the curing process without falling into No. 2 or No. 3 grade because of lack of green color.

THE STAGE FOR CUTTING CLOVERS

The clovers should be cut at or near the time of maximum yield of protein per acre because the percentage of protein in clover hay is largely a measure of its feed value.

The Ohio Agricultural Experiment Station has reported that the percentage of protein of the clovers declines rapidly from the bud or heading-out stages to full bloom and more slowly from full bloom until the seed is mature (table 1). Experimental work in some of the clover-producing States has shown that in the case of medium red clover the highest yield of hay per acre may be expected from the half- to the full-bloom stage. The yield of protein per acre, however, is the greatest when approximately 50 percent of the plants are in bloom, but it does not show a material decrease until after the full-bloom stage. It appears desirable, therefore, to begin cutting me-

dium red clover when about half of the plants are in bloom. Cutting should be finished by the time the plants are in full bloom.

TABLE 1.—*Total yields, percent protein, and total protein per acre for medium, mammoth, and alsike clover at different stages of maturity* [1]

Stage of maturity when cut [2]	Medium red			Mammoth red			Alsike		
	Yield of hay per acre [3]	Protein in hay [4]	Protein per acre [3]	Yield of hay per acre [3]	Protein in hay [4]	Protein per acre [3]	Yield of hay per acre [3]	Protein in hay [4]	Protein per acre [3]
	Pounds	*Percent*	*Pounds*	*Pounds*	*Percent*	*Pounds*	*Pounds*	*Percent*	*Pounds*
Buds	1,530	22.4	343	2,790	18.8	524	1,220	23.7	289
First flowers	1,980	21.1	418	3,070	17.3	531	1,650	21.6	356
50-percent bloom	3,010	15.9	478	3,460	15.9	550	2,160	18.2	393
Full bloom	3,100	14.9	462	3,800	14.4	547	2,810	16.0	450
Ripe	2,610	12.1	316	3,540	12.8	453	3,320	13.4	445

[1] Compiled from Bimonthly Bull. No. 167, Ohio Agricultural Experiment Station.
[2] The bloom indications given here are only approximate. It is particularly unsatisfactory to designate the stage of maturity of alsike clover by bloom since this clover continues to grow and bloom for a considerable period.
[3] Average of 4 years.
[4] Average of 3 years.

Mammoth red clover produces the greatest number of pounds of hay per acre when cut at about the full-bloom stage, but the greatest number of pounds of protein per acre will be obtained if the cutting is done when approximately 50 percent of the plants are in bloom. The cutting of mammoth red clover should also begin when about half of the plants are in bloom and should be completed by full bloom.

Alsike clover, which has a continuous growth habit especially on moist soils, gives the greatest yields of hay per acre if cut when most of the flowering heads have turned brown. The greatest yields of protein per acre are obtained when the plants are cut in full bloom. Alsike clover, when grown alone, has a greater tendency to lodge as it approaches maturity than the red clovers and therefore should be cut at about the same stage of maturity as medium red and mammoth red clover.

Because of the importance of clover in the mixture, medium red or mammoth red clover containing a mixture of timothy should be cut when the clover is in the half- to the full-bloom stage (fig. 4). Mixtures of timothy and mammoth red clover may be sown to advantage because they reach the proper stage for cutting at about the same time. But medium red clover reaches the right stage for cutting about 10 days to 2 weeks earlier than the timothy.

Alsike clover containing enough timothy to prevent the clover from lodging may be cut for hay when the timothy is in the fully-headed-out to full-bloom stage of growth. At this intermediate stage both the clover and timothy will produce the maximum quantity of protein per acre.

When the larger part of the timothy and clover mixture is timothy, cutting should be delayed until the timothy is fully headed out, but should be finished by the time the timothy reaches the full-bloom stage (fig. 3). With this type of mixture it appears desirable to sacrifice the quality of the clover in order to obtain the maximum quantity of protein per acre from the timothy.

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RELATION OF MATURITY OF CLOVER AT TIME OF CUTTING TO COLOR

A greater amount of natural green color may be preserved in clover that is cut from the half- to full-bloom stage than in clover cut after the heads begin to turn brown. Clover loses its bright, green color and becomes dull or greenish brown when the plants are permitted to become too mature. The stems of late-cut clover usually become coarse and woody and require a long curing period to reduce the moisture content to a point at which the hay may be safely stacked, baled, or mowed.

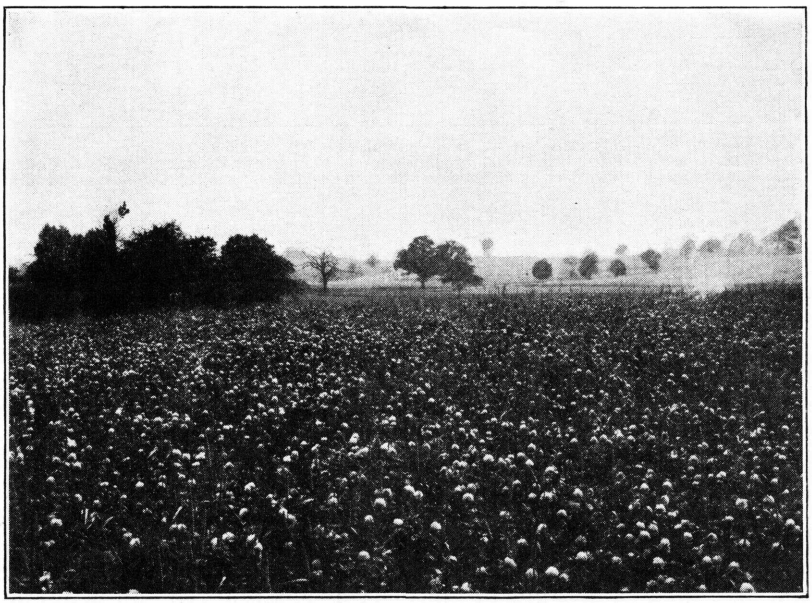

FIGURE 4.—A field of clover and timothy. The clover is in the half- to full-bloom stage just ready for cutting.

TIME OF CUTTING TIMOTHY AND GRASS MIXTURES

Most grasses that are sown with or occur naturally with timothy hay mature earlier than timothy. These grasses also lose their feeding value much more rapidly than timothy after they reach the bloom stage. This makes it necessary to cut timothy and grass mixtures when the grasses have reached the full-bloom stage without regard to the maturity of the timothy so that the mixture may retain its palatability. Unless timothy and grass mixtures are cut at the right time the grass part of the mixture loses some of its feeding value and turns straw-colored which greatly detracts from the sale value of the hay.

The nutritive value of such grasses as redtop, orchard grass, and bluegrass, if cut at the proper time, will nearly equal that of timothy.

EFFECT OF WEATHER DAMAGE ON QUALITY

If timothy and clover hay is cut and left in the swath or windrow for any length of time it will sun-bleach and lose some of its natural green color. Sun-bleached hay is often produced in those sections in

which it is a common practice to dry the hay fully in the swath before raking. The exact effect of sun-bleach on the feeding value of hay is not definitely known. It decreases palatability, however, because the hay becomes dry and brittle and causes a loss of vitamin A through a reduction in green color. Sun-bleaching develops a bright yellow color instead of the natural green. This lowers the grade and affects the sale value. Livestock relish green hay more than brown. Higher prices are paid for exceptionally green hay whereas discolored hay sells at a discount. Small quantities of sun-bleach in early-cut hay usually do not lower the green below the minimum color requirement for the U. S. No. 1 grade.

Slight discolorations in timothy and clover hay are often caused by dew. One or more heavy dews may even be enough to lower the grade, but ordinarily discolorations caused by a light dew will not materially lower the feeding value provided the hay is properly cured and handled. If the discoloration is considerable the appearance as well as the feed and market value are likely to be affected.

Timothy and clover hay that is partially or completely cured loses its feeding value very rapidly when rained upon. The extent of the loss depends on the duration of the rainfall. A light shower on freshly cut, unwilted hay will cause less damage than the same amount of rain on hay that is partially or completely cured. Light showers, especially if the surface soil is full of moisture at the time the hay is cut, will reduce the amount of green color and will damage the hay to a certain extent because the hay will cure more slowly. If the shower is immediately followed by warm, sunshiny weather, the destruction of green color is hastened. The evidence of slight damage is found in yellow or straw-colored discolorations. Severe weather damage and extensive loss of color are commonly caused by heavy rains or numerous showers when hay is in the swath, windrow, or cock. Hay stacked out of doors in small or flat stacks which do not shed water is often severely damaged by rains. The evidence of severe weather damage is found in the dark-brown or faded colors or stains.

Experiments indicate that rain usually leaches the soluble substances from hay, destroys all or part of the green color, and lowers its palatability. Weathered hay is usually harsh and brittle. Because of its appearance and low-feeding value, it is probably discriminated against in the market to a greater degree than hay damaged from other causes.

EFFECT OF FERMENTATION ON QUALITY

Fermentation, often referred to as sweating, is caused by baling, stacking, or mowing undercured or wet hay. Sweating of newly-harvested hay may increase its palatability by softening the stems and improving the aroma. On the other hand, excessive fermentation may result in serious damage through the destruction of green color and the development of mold and must. Unless it is overcured in the field, hay sweats or ferments after it is baled, stacked, or placed in the mow. The changes in the quality and condition that result from fermentation are chiefly dependent on the amount of moisture in the hay, and relative humidity and temperature of the atmosphere.

Little is known about the effects of fermentation on the feed value of timothy and clover hay. With the moderate sweating that takes

place in properly cured hay little or no loss of green color occurs. Unless fermentation is severe and the hay becomes unsound, any change in quality will be limited to destruction of green color. In most cases distinctly fermented hay ranges in color from greenish brown to brown. Fermentation may even cause tightly baled hay to "set" slightly without becoming unsound, but ordinarily set or caked hay is moldy or musty. The cores of bales of fermented hay are often discolored although the outer part of the bales is unaffected, just as hay in the center of stacks or mows is sometimes badly discolored from fermentation when the hay on the outer part, where air circulation prevents excessively high temperatures, shows little or no discoloration. Hay that is severely discolored from stack or mow fermentation is often referred to as stack- or mow-burnt hay. Proper curing and storing of hay will prevent reduction in quality because of fermentation.

Fermentation of wet or undercured hay may cause high temperatures to develop. Such hay, which is warm to the touch and gives off a strong, sour odor, is called heating or hot hay. The temperature of hot hay occasionally becomes high enough to cause spontaneous ignition. Baled hay that is heating can often be reconditioned through aeration, but in most cases if it is distinctly heating it becomes musty and moldy. Must and mold are usually associated together in hay that has heated. Must is the sour odor usually accompanying moldiness and is evidence of a damaged condition in the hay even though the mold itself is not visible. Molds are the fungus plant organisms that develop in hay when moisture and temperature conditions are favorable for their growth. The development of mold is one of the first steps in the decomposition of hay.

FOREIGN MATERIAL IN TIMOTHY AND CLOVER HAY

Foreign material in timothy and clover hay refers to weeds and such other plants as are coarse and not ordinarily of feed value, and to cornstalks, grain stubble, chaff, and other objectionable material that occurs naturally in hay. In the timothy and clover standards, in order to take care of normal production conditions, a maximum of 10 percent of foreign material is permitted in the grade U. S. No. 1, 15 percent in the grade U. S. No. 2, and 20 percent in the grade U. S. No. 3. Hay that contains over 20 percent but not over 35 percent of foreign material is placed in Sample grade.

Separation analyses made on many representative bales of timothy and clover hay from numerous markets throughout the timothy and clover area, indicate that, even with these percentage allowances of foreign material in the three numerical grades, approximately 10 percent of the hay falls into Sample grade because of foreign material. The average quantity of foreign material for these bales was 30 percent and consisted principally of daisies, buckhorn, dock, and other weeds that are common in timothy and clover meadows.

Foreign material is pure waste or dockage in hay. It is usually rejected by livestock and remains uneaten in the feed manger. When hay is bought by a livestock feeder he does not get full value for his money if the hay contains much foreign material. It is therefore just and fair that the grade and, thus indirectly, the price should be lower when the hay contains much of this kind of material.

It is recognized that a small quantity of weeds and other foreign material occurs naturally in the production of hay and that meadows that are free from weeds are uncommon. Excessive foreign material in timothy and clover hay, especially clover, is due to foul land and the use of low-grade seed. Certain types of weeds, such as daisies and buckhorn, are difficult to detect, particularly in clover and timothy and clover mixtures because the stems of these weeds are often of the same color as the clover stems, and unless one is familiar with them they will be overlooked or considered as clover. Certain other types of foreign material such as grain stubble and cornstalks tend to give baled hay a bad appearance in proportion to the quantity present by weight. The percentage of weeds in tightly compressed bales is often difficult to determine.

Foreign material that causes mechanical injury or is poisonous to livestock is not a serious problem because very few of these plants occur in timothy and clover meadows.

PRODUCTION OF HIGH-QUALITY TIMOTHY AND CLOVER HAY

On many farms the hay crop receives less thought and attention than field crops like corn, wheat, oats, tobacco, or potatoes. But if hay is to be relied upon as a cash crop or used as a basis of a dairy or stockfeeding program it must be managed with the same degree of forethough and attention as the good farmer gives to any other cash crop.

High-quality hay cannot be produced for either market or home use unless the producer plans ahead to have clean meadows, to cut the hay at the proper stage of maturity, to cure and store the crop as quickly as possible, and if produced for market to bale and load the hay according to market demands. The producer who plans to use the hay as feed for dairy cattle, stock cattle, or sheep should store it so as to prevent spoilage in the mow or stack. This will preserve the feed value of the roughage which in turn will reduce the quantity of concentrates necessary to give maximum gains and milk production at a minimum cost. The cost of producing low-quality hay is just about the same as the cost of producing high-quality hay and the feed value or return per dollar invested is much lower.

It does not pay, ordinarily, to ship low-quality hay to market because of high transportation costs and low net returns. Feeding low-quality hay to farm animals will usually reduce the returns to the farmer or livestock feeder in the production of meat and dairy products. Some of the important features that have a direct relationship to hay quality are here considered.

GOOD STAND NECESSARY TO HIGH-QUALITY HAY

Good crops of high-quality hay cannot be produced from thinly sown meadows or from very old meadows where the stand has become thin because invariably such meadows are weedy. The foundation of the business of producing high-quality hay is a good meadow, free from weeds, and so seeded as to produce a thick stand of hay. The rate of seeding per acre recommended by the forage-crop authorities of the State agricultural experiment stations should be used in order to obtain a good stand.

Wherever soil conditions permit, the kind of pure hay or mixed hay should be grown which is known to be in the greatest demand at the

markets available to the producer and shipper, or will give best returns in the dairy or livestock-feeding program.

Good policy in the production of hay for market, as well as good crop-rotation practice, requires the occasional breaking up of old meadows. Their yield per acre is low and the percentage of weeds and grasses other than timothy is usually high. There are prejudices against grass-mixed hay in many markets and among livestock feeders.

CURING METHODS TO PRESERVE LEAFINESS AND COLOR

Haymaking methods must necessarily vary with the kind of hay, the local climatic conditions, the farm conditions and buildings, and the available labor and machinery. The proper curing of hay rests chiefly on the judgment, energy, and experience of the farmer. A few of the most common errors made in curing and storing which are reflected in the low quality of hay produced in the timothy and clover section are here pointed out.

Loss of quality from excessive swath bleaching, or fermentation in storage, or from poorly built stacks can be controlled by proper handling. Losses from rain damage in the swath and windrow cannot usually be controlled and at best can be only minimized.

In many districts hay is allowed to dry too long in the swath. This causes excessive bleaching with loss of bright, natural green color and carotene content. Wherever the dump rake is used in haymaking, and where it is not planned to cock the hay, it is a common practice to cure the hay completely in the swath and then to rake it into windrows shortly before it is hauled. On bright, hot days this method is conducive to swath bleaching and overdrying of the leaves of clover which are shattered and lost when the dry hay is raked. Such improper handling often greatly reduces the feed value.

These methods, which may lower the grade of hay, can be remedied to a considerable extent by the intelligent use of the side-delivery rake, especially when heavy mixtures of clover are being handled. The effectiveness of this rake, and the principles underlying its use, demand that the raking shall be done when the hay in the swath is somewhat sappy and not when it is well dried. When hay is rolled into somewhat cylindrical windrows with the side-delivery rake many leaves within the loose roll are protected from overdrying and will cling to the stems. Furthermore, a large part of the leaves and stems will cure without bleaching. Farmers in the timothy and clover areas who handle relatively large quantities of hay and who store it in barns or sheds have conditions that necessitate the use of the side-delivery rake and the hay loader in curing hay and moving it swiftly from the windrow to the barn.

STORAGE METHODS TO PRESERVE QUALITY

Timeliness is an important factor in handling hay to preserve quality. The question is often raised as to when hay is cured enough for safe storage and what rule-of-thumb methods can a farmer use to determine the moisture content.

There are no simple methods of moisture determination that can be relied on in practical haymaking. But every effort should be made to haul and store at that stage of curing when the hay is no longer sappy but before it becomes dry and brittle. Experiments

carried on by the State experiment stations indicate that this stage is reached when the hay contains from 22 to 25 percent of moisture. Farmers who are experienced in curing hay do not find it difficult to determine when the hay is ready for storage, providing it is cured uniformly, but they always are careful about storing if there are undercured bunches mixed with the cured hay. They believe that these undercured bunches are liable to be the center of heating areas or pockets that may become moldy or may even cause spontaneous ignition. Hay that is stored while still slightly tough goes through a sweat in the mow or stack, which usually improves the palatability of the hay.

In the Central States, as well as in Maryland, Virginia, and West Virginia, timothy and clover hay are often stacked by hand, in low, flat stacks or tall, narrow stacks, about a central pole of 2 to 4 tons in a stack. Such stacks weather badly and often become severely stained and partly rotten. When used for feed or shipped to market the returns are usually very low either in animal products or in cash returns.

It is a poor practice to store hay in small stacks because so much of it is exposed to weather. Timothy and clover hay can be stacked directly from windrows with the sweep rake and stacker. Stacks holding 10 to 15 tons can be built easily with either of several types of hay stackers. If symmetrically built and well tramped in the center, these stacks shed water so that severe weathering occurs only on the outside. The percentage of weather-damaged hay to total stack tonnage is much less in large than in small stacks. The risk of damage to the center is small if the stack is built with side-wall bulges 3 to 4 feet above ground level, is well tramped in the center, and is drawn to a peak at the top. In areas of heavy rainfall, a small load of straw or grass hay may be spread over the top to assist in shedding the rain.

In the North Atlantic States and to a certain extent in the Mississippi Valley timothy and clover hay is stored in barns that are used to house the livestock or used entirely for hay. Barn-stored hay will not be damaged further by weather if the barn has a good roof, but greater care must be taken regarding the moisture content because of the greater loss in case of spontaneous ignition.

Much interest is shown in the practice of chopping the hay into short lengths at the time of storage to reduce the storage space and the labor involved. Indications are that the cost of using power machinery for chopping and storing hay will just about offset the saving in labor. Two to two and one-half times as much chopped hay can be stored in the same space as required for long hay, and chopped hay can be removed from the mow for feeding much easier. But the keeping qualities of the hay are influenced by the depth of the hay in the mow, its texture, and length, as well as by its moisture content. Fine-stemmed hay that is cut into short lengths increases the density of the mow which encourages fermentation.

MINIMIZING RAIN DAMAGE TO HAY

Rain damage while hay is in the swath, windrow, bunch, or cock is the hay producer's greatest bugbear. Sometimes summer showers or unexpected heavy rains spoil the plans of the best farmers. One

practice that should always be followed is to cut only the quantity of hay that can be handled with the available crew before it becomes overdried. Hay that is left in the swath or windrow after it is thoroughly cured loses quality very rapidly.

Over a period of years, careful planning of the cutting and raking operations and the use of modern machinery to move the hay from the windrow to the stack or mow will eliminate many of the severe losses caused by rain damage. Several commonplace facts should be kept always in mind. If hay has been cut and a rain is coming the hay will receive less damage in the swath than in the windrow, and less damage in the windrow than in the big bunch made by the dump rake from the windrow. If the hay is left in the cock overnight or over Sunday the cock should be built up large and high with hand-pitching, because hay in a flat, low-built cock made with the dump rake or fork will be damaged more if it should rain.

The practice of cocking hay to sweat it in the field or to prevent rain damage is not much used now. The haymaker's plans for holding down the rain damage must place more reliance upon the side-delivery rake, the hay loader, the sweep rake, the stacker, and the organization of his crew to provide rapid haulage and storage than upon the more expensive and tedious practice of cocking.

PREPARATION OF HAY FOR MARKET

Care used in the preparation of hay for market has an influence on the quality of the hay and the price producers receive for it. Buyers are getting acquainted with the factors of quality, such as color, foreign material, and condition, that are related to feeding value. Poor baling and improper loading of cars are reflected in an increased spread in the cost of marketing hay, most of which is borne either by the shipper or buyer. Hay should be baled and loaded so it meets the demands of the market where it is to be sold.

Whenever an individual producer, a neighborhood group of producers, or others interested in the baling of market hay are considering the purchase of a hay press, good baling practice requires that the type of press be selected that will put out bales of the size and weight best adapted to the demands of the markets in which the hay is to be sold. Some hay markets favor one type and size of bale and are prejudiced against other types. The shipper and producer will always benefit by catering to the preference of his market. He cannot afford to ignore the established market demands.

Bales of market hay should be neat in appearance and tightly tied. Ragged-looking bales loosely or unevenly tied sometimes bring a smaller price merely because they are unattractive and the bales may break. The bunches of coarse weeds and damaged hay that are often found mixed with good hay should not be fed into the press. Slugs containing weeds or other foreign material or unsound hay can hurt the appearance of good hay.

When hay is baled from the stack or mow the utmost care should be taken to remove the weathered top and sides and all the moldy stack- or mow-burnt hay that may be found in the center. The bottom layer of stacked hay that has been next to the ground should not be baled. A relatively small quantity of such damaged hay will spoil the appearance of really good hay. Stack- or mow-damaged

hay may have some value on the farm where produced but it is likely to cause the shipper financial loss if shipped to market.

Hay often arrives at the market that was properly cured and stored but that received enough moisture from snow or rain during the baling or loading period to cause it to heat while in transit. Such hay is usually unsound and is either rejected or sold at a discount. Shippers should bale and load only during days of bright weather and should protect the piles of bales from snow or showers.

The baling of hay, especially legume hay, from stacks or mows on days when the humidity is relatively high will minimize the loss of leaves and breaking of stems. Hay baled during the winter when the weather is windy or when the temperature is below freezing is often badly shattered and broken during the baling.

It is not advisable to bale hay from the windrow or cock unless curing conditions are very favorable then. Every year when the early field-baled shipments move to market much of the hay arrives in a hot or moldy condition. Sweating is likely to take place in the bales during transit or in the warehouse, and the tightly packed bales are likely to heat, ferment, and mold. If hay that is to be baled from the windrow is overdried in the swath to prevent heating the loss of color lowers the quality.

As a general rule the stack or mow storage of hay to allow sweating before baling is better than to bale from the windrow. A higher moisture content can be permitted in loose hay to be stored than in hay that is to be baled directly from the windrow. Occasionally it may be justifiable and profitable to bale the hay from the field when there is a shortage in the markets during the summer and prices are unusually high. Then field baling to rush hay into an early market may make extra profits providing the hay is fully cured before baling. The hay should be piled on edge in the field or barn so the air can circulate around the bales during the sweating process, to prevent heating. The occasional savings of labor, or the early-market profits, that may sometimes be possible in field baling are usually more than offset, during a term of years, by the losses in quality from the storage or shipment of partially cured hay.

LOADING HAY ON CARS OR TRUCKS

Hay that is properly loaded for shipment to market is attractive.

The piling of baled hay in the barn or in the field gives an excellent opportunity to grade and sort the hay before loading for shipment. At this time in the preparation of hay for market, all widely different classes and grades should be separated. If any bales of distinctly low-quality hay have been pressed with bunches of weeds or spoiled hay, they should be withheld from shipment. If different classes of hay have been baled from different meadows, such as Timothy, Timothy Medium Clover Mixed, or Timothy Light Grass Mixed, the various classes should be separated so far as possible because it is not good policy to load a number of classes of hay in the same car or on the same truck, if it can be avoided. Similarly, if a part of the hay is U. S. No. 1 grade, cured without rain damage, and another part is U. S. No. 2 grade because of excessive sunbleach or moderate rain damage, it is best to separate the two grades before loading. Buyers who order a car or truck lot of hay of any

specific grade expect the delivery of a uniform load according to their specifications and are not satisfied with mixed car or truck lots.

If bales of hay of different grades or classes are loaded promiscuously in the same car or on a motor truck it is very difficult for the inspector at destination to place a proper grade on the entire lot. When bales of two distinct grades or classes are intermingled he cannot average the grades and designate one grade for the entire car or truck lot. The best he can do is to count the bales of each class and grade and certify that he inspected so many bales of the various classes and grades. In case of doorway inspection, the presence of bales of different grades raises doubt in the buyer's mind as to the uniformity of the entire carlot so the hay may not sell to the best advantage. The better policy is to load hay of uniform grade because hay merchants can sell uniformly loaded cars or truck lots for better prices than nonuniform lots.

A shipper does not always have enough hay of uniform grade to fill one car or truck or to complete a shipment of several car or truck lots. Then the best plan is to load bales of one class or grade in one end of the car and bales of a different class or grade in the other end. The total number of bales loaded in each car, together with the number of bales of each class or grade, should be stated plainly on the shipper's invoice. This practice of describing the hay shipment fully and frankly on the invoice is appreciated by receivers and helps the shipper to market hay advantageously. Ultimately such a practice, consistently followed, builds up a reputation for the shipper that creates a demand for his product.

On the other hand, the policy of loading U. S. No. 1 hay in the car doorway and concealing low-grade hay in the ends of the car, or the practice of slipping in 10 or 15 bales of damaged hay in every car or truck, believing they will be overlooked, usually brings trouble and causes loss to the shipper. Wherever plug inspection exists (which means opening up an alleyway through the tiers of bales in the car before inspection) the variation in grade is sure to be discovered to the eventual, if not immediate, detriment of the shipper. Even under doorway inspection, plugged carlots of hay are sure to be discovered when the hay is unloaded, and the buyer will call for another inspection on the hay that was not inspected in the doorways.

Bales of newly harvested hay should be placed on edge in the car and space left between the tiers of bales and between the top bales and the roof of the car so that the air can circulate more readily and reduce the possibility of heating while the hay is in transit. It is best to have the ends of the bales face the car doorways or the outside of the truck. This way of loading presents the hay to the buyer in the most attractive way.

Hay is so bulky and the carload is so low in value in proportion to the carlot freight rate, which has increased during recent years, that under normal market conditions it pays best to bale and load only good sound hay of uniform grade. The steady and normal market demand is for the U. S. No. 1 and U. S. No. 2 grades. The U. S. No. 3 grade and certain types of U. S. Sample grade hay sell to advantage only when unusual shortages bring a strong demand for any hay that can be fed.

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